

REMARKS

In view of the above amendments and the following remarks, reconsideration of the rejections contained in the Office Action of May 13, 2008 is respectfully requested.

By this Amendment, claims 1, 5 and 8 have been amended, and new claims 9 and 10 have been added. Thus, claims 1, 4, 5 and 8-10 are currently pending in the application. No new matter has been added by these amendments.

Revisions have been made to the specification, as identified above. It is noted that support for the amendments to the specification can be found at page 12, lines 18-25 of the original specification. No new matter has been added by the revisions. Entry of the amendments to the specification is thus respectfully requested.

On pages 3-6 of the Office Action, the Examiner rejected claims 1, 4, 5 and 8 under 35 U.S.C. § 103(a) as being unpatentable over Borsboom et al. (US 4,981,661) in view of Srinivas et al. (US 6,099,819) and Forg et al. (US 5,660,807). For the reasons discussed below, it is respectfully submitted that the amended claims are clearly patentable over the prior art of record.

Amended independent claim 1 recites a COS treatment apparatus for a gasified gas containing H₂S, H₂O, O₂, and CO. The COS treatment apparatus of claim 1 includes a first reactor into which the gasified gas is to be introduced, with the gas having a temperature of at least 300°C, and a second reactor located at a downstream side of a gasified gas flow with respect to the first reactor. Claim 1 also recites that the first reactor comprises an O₂ removal catalyst for accelerating the following reaction: 2H₂S + 2CO + O₂ → 2COS + 2H₂O, with the O₂ removal catalyst being a TiO₂ catalyst carrying Cr₂O₃ or NiO. Further, claim 1 recites that the second reactor comprises a COS conversion catalyst.

Amended independent claim 5 recites a COS treatment method for a gasified gas containing H₂S, H₂O, O₂, and CO. The method of claim 5 includes removing O₂ from the gas by using a TiO₂ catalyst carrying Cr₂O₃ or NiO at a gas temperature of at least 300°C to accelerate the following reaction: 2H₂S + 2CO + O₂ → 2COS + 2H₂O. The method of claim 5 also includes, after the removing of O₂ from the gas, converting COS contained in the gas to H₂S by using a COS conversion catalyst.

Borsboom discloses a process for removing sulfur compounds from a CO containing gas.

In particular, Borsboom discloses that O₂ is removed from a gasified gas by the hydrogenation of O₂ under a Co-Mo catalyst prior to the hydrolysis of COS. Borsboom also discloses that the hydrogenation of O₂ occurs in accordance with the following reaction: 0.5O₂ + H₂ → H₂O + heat (Equation (6) of Borsboom).

However, as noted by the Examiner on page 3 of the Office Action, Borsboom does not disclose that *an O₂ removal catalyst is a TiO₂ catalyst carrying Cr₂O₃ or NiO*, as required by independent claims 1 and 5. Accordingly, it is respectfully submitted that independent claims 1 and 5 are not anticipated by Borsboom.

Srinivas discloses catalysts for the selective oxidation of hydrogen sulfide. In particular, Srinivas discloses a catalyst which includes a mixture of TiO₂ and one or more oxides of a group of metals which includes Cr and Ni. Srinivas discloses that the catalyst is used for selectively oxidizing hydrogen sulfide according to the following reaction: H₂S + 0.5O₂ → H₂O + S (Equation (1) of Srinivas).

On page 3 of the Office Action, the Examiner asserts that Srinivas discloses that a TiO₂ catalyst carrying Cr₂O₃ or NiO is an O₂ removal catalyst, and therefore concludes that it would have been obvious to one of ordinary skill in the art to use the catalyst with the teachings of Borsboom to arrive at the present invention. However, Srinivas does not disclose or suggest that a TiO₂ catalyst carrying Cr₂O₃ or NiO is an O₂ removal catalyst. Rather, Srinivas discloses that the catalyst selectively oxidizes hydrogen sulfide into sulfur and water, as shown in Equation (1) of Srinivas. In other words, Srinivas discloses a catalyst which produces sulfur and water, and does not disclose an O₂ removal catalyst, as required by independent claims 1 and 5.

Further, it is noted that Borsboom discloses that the oxidation of hydrogen sulfide into sulfur is problematic because the resulting sulfur will solidify and cause clogging when the gas is cooled (column 2, lines 19-26). Thus, as Srinivas only discloses a catalyst for oxidizing hydrogen sulfide into sulfur, it would not have been obvious to one of ordinary skill in the art to use the catalyst of Srinivas with the apparatus of Borsboom, because Borsboom expressly teaches away from oxidizing hydrogen sulfide into sulfur.

Forg discloses a process for the removal of HCN from gas mixtures. In particular, Forg discloses a catalyst including titanium dioxide and chromium for decomposing HCN and COS.

However, Forg does not disclose *an O₂ removal catalyst for accelerating a reaction of 2H₂S + 2CO + O₂ → 2COS + 2H₂O at a temperature of at least 300°C*, as required by independent claims 1 and 5. Rather, Forg only discloses a catalyst for decomposing HCN and COS at temperatures of 130°C to 250°C.

Therefore, for the reasons presented above, it is believed apparent that the present invention as recited in independent claims 1 and 5 is not disclosed or suggested by the Borsboom reference, the Srinivas reference and the Forg reference taken either individually or in combination. Accordingly, a person having ordinary skill in the art would clearly not have modified the Borsboom reference in view of the Srinivas reference and the Forg reference in such a manner as to result in or otherwise render obvious the present invention of independent claims 1 and 5.

Independent claim 9 recites a COS treatment apparatus for a gasified gas containing H₂S, H₂O, O₂, and CO. The treatment apparatus of claim 9 includes a reactor into which the gasified gas is to be introduced, with the reactor comprising a TiO₂ catalyst carrying Cr₂O₃ and BaO. Claim 9 also recites that the TiO₂ catalyst carrying Cr₂O₃ and BaO is an O₂ removal catalyst for accelerating the following reaction: 2H₂S + 2CO + O₂ → 2COS + 2H₂O, and that the TiO₂ catalyst carrying Cr₂O₃ and BaO is a COS conversion catalyst.

Independent claim 10 recites a COS treatment method for a gasified gas containing H₂S, H₂O, O₂, and CO. The method of claim 10 includes removing O₂ from the gas by using a TiO₂ catalyst carrying Cr₂O₃ and BaO to accelerate the following reaction: 2H₂S + 2CO + O₂ → 2COS + 2H₂O. The method of claim 10 also includes simultaneously converting COS to H₂S by using the TiO₂ catalyst carrying Cr₂O₃ and BaO.

It is noted that none of the Borsboom, Srinivas and Forg references discloses *a reactor comprising a TiO₂ catalyst carrying Cr₂O₃ and BaO, wherein the catalyst is an O₂ removal catalyst for accelerating the following reaction: 2H₂S + 2CO + O₂ → 2COS + 2H₂O, and wherein the catalyst is a COS conversion catalyst*, as required by independent claim 9. Similarly, none of the Borsboom, Srinivas and Forg references discloses includes a method which includes *removing O₂ from the gas by using a TiO₂ catalyst carrying Cr₂O₃ and BaO to accelerate the following*

reaction: $2H_2S + 2CO + O_2 \rightarrow 2COS + 2H_2O$, and simultaneously converting COS to H_2S by using the TiO_2 catalyst carrying Cr_2O_3 and BaO , as required by independent claim 10.

Therefore, for the reasons presented above, it is believed apparent that the present invention as recited in independent claims 9 and 10 is not disclosed or suggested by the Borsboom reference, the Srinivas reference and the Forg reference taken either individually or in combination. Accordingly, a person having ordinary skill in the art would clearly not have modified the Borsboom reference in view of the Srinivas reference and the Forg reference in such a manner as to result in or otherwise render obvious the present invention of independent claims 9 and 10.

In addition, the Examiner's attention is directed to the dependent claims which further define the present invention over the prior art. In particular, dependent claim 4 recites that *the O_2 removal catalyst is located in a higher-temperature region with respect to the COS conversion catalyst*. Similarly, dependent claim 8 recites that *the removing O_2 from the gas is performed at a higher temperature with respect to the converting COS to H_2S* . In this regard, on pages 4 and 6 of the Office Action, the Examiner indicates that column 2, lines 39-55 of Borsboom discloses that the O_2 removal catalyst is located in a higher-temperature region than the COS conversion catalyst.

However, it is noted that the section of Borsboom cited by the Examiner (*i.e.*, column 2, lines 39-55) discloses a process which includes "(a) a first stage comprising converting a portion of the CO present with water in the presence of a catalyst with simultaneous or subsequent hydrogenation of any O_2 ," and "(b) a second stage comprising catalytically hydrolyzing COS." Further, the section of Borsboom cited by the Examiner (*i.e.*, column 2, lines 39-55) discloses that the catalytic conversion of the CO in stage (a) produces heat which can raise the temperature of the gas to the value required for the second stage. In other words, Borsboom discloses that the gas has a lower temperature at the first stage, and is heated up to the required temperature of the second stage.

More specifically, it is noted that Borsboom discloses that the temperature of the gas supplied to the first stage (*i.e.*, the O_2 removal stage) is at least 200° C, and that the feed of the

second stage will be at least 25° C hotter than the feed in the first stage (see column 4, lines 37-41). Therefore, Borsboom does not disclose that the O₂ removal catalyst is located in a higher-temperature region with respect to the COS conversion catalyst, as required by dependent claims 4 and 8, because Borsboom discloses that the O₂ removal stage occurs at a *lower* temperature than that of the second stage.

Therefore, it is respectfully submitted that independent claims 1, 5, 9 and 10, as well as claims 4 and 8 which depend therefrom, are clearly allowable over the prior art of record.

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is clearly in condition for allowance. An early notice to that effect is respectfully solicited.

If, after reviewing this Amendment, the Examiner feels there are any issues remaining which must be resolved before the application can be passed to issue, the Examiner is respectfully requested to contact the undersigned by telephone in order to resolve such issues.

Respectfully submitted,

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